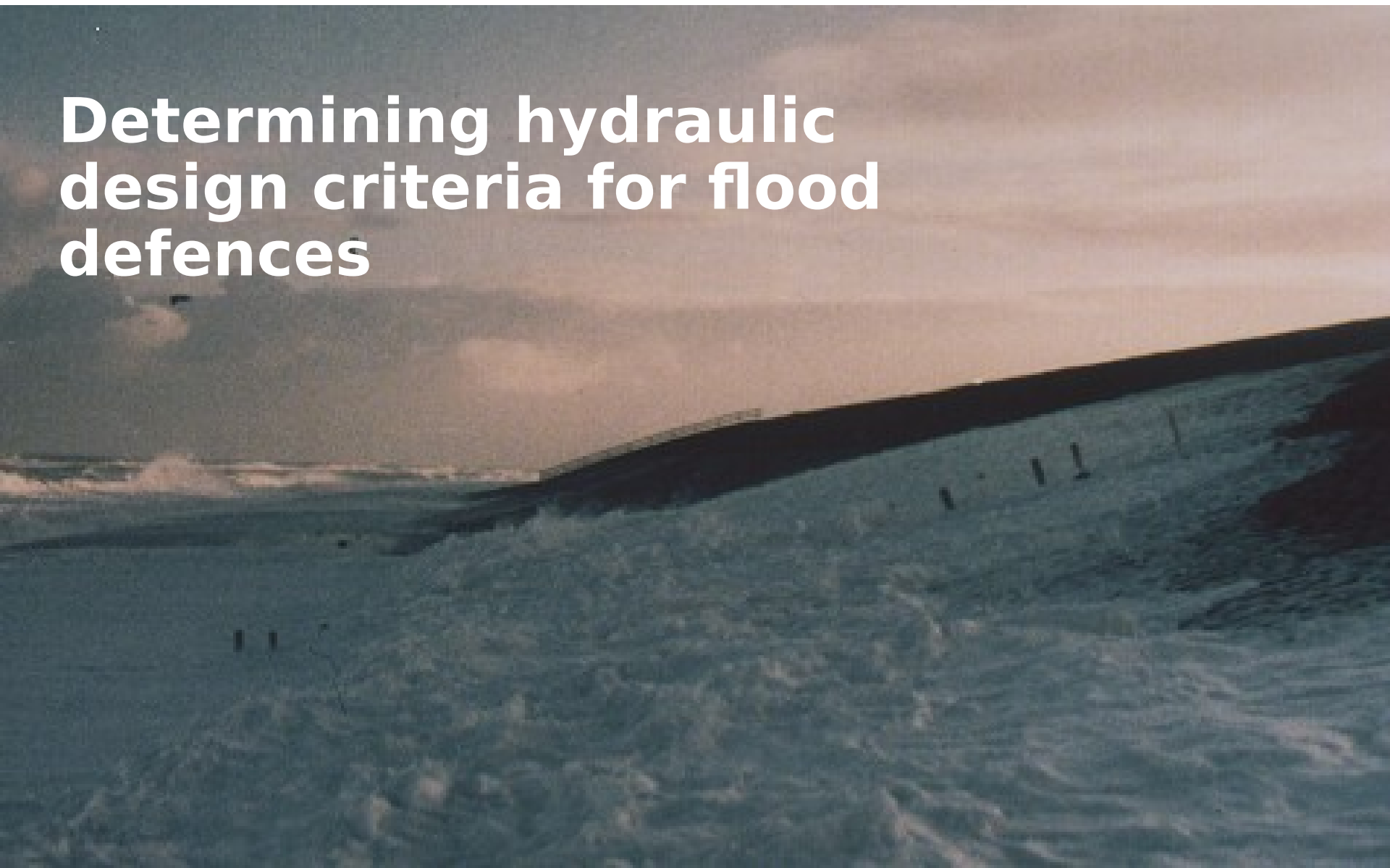




# Determining hydraulic design criteria for flood defences



# Contents

1. Safety standards and safety assessment in the Netherlands
2. Hydraulic Boundary Conditions
3. Design aspects

# Determining er models

Flooded area in the  
absence of all flood  
defences

The Netherlands  
Flooded area in the absence  
of all water defences

Legend

-  flooded area
-  river / inland waterway
-  sea
-  high grounds (also outside The Netherlands)
-  primary water defence outside The Netherlands

North Sea

Germany

Belgium

0 20 40 60 km

Basiskaart Meeth. Dienst afd. G.A.T. ('96) bewerkt door R.P. v.d. Laag (06/98)

# Examples of defence systems in NL



# Determiner models Safety standard

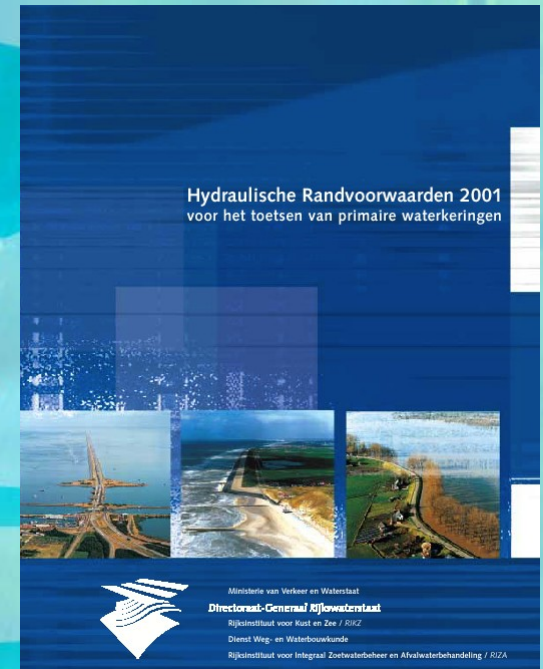
The Netherlands  
Safety Standard  
per Dike-ring area

Legend



# Safety assessment

- prescribed by Flood Defence Act
- performed each 5 years
- performed by water boards
- minister informs parliament
- Hydraulic Boundary Conditions give the required hydraulic information



# Determining design criteria using computational models

## Hydraulic Boundary Conditions

11 juli  
2006

consists of water levels and waves

based on statistics about

- River discharge
- Wind speed and wind direction
- Sea level during storm surges
- Lake level
- Failure chances of storm surge barriers

and using hydraulic and probabilistic models (Hydra)

Hydraulic Boundary Conditions are dependent on safety standard

# Determining design criteria using computational models

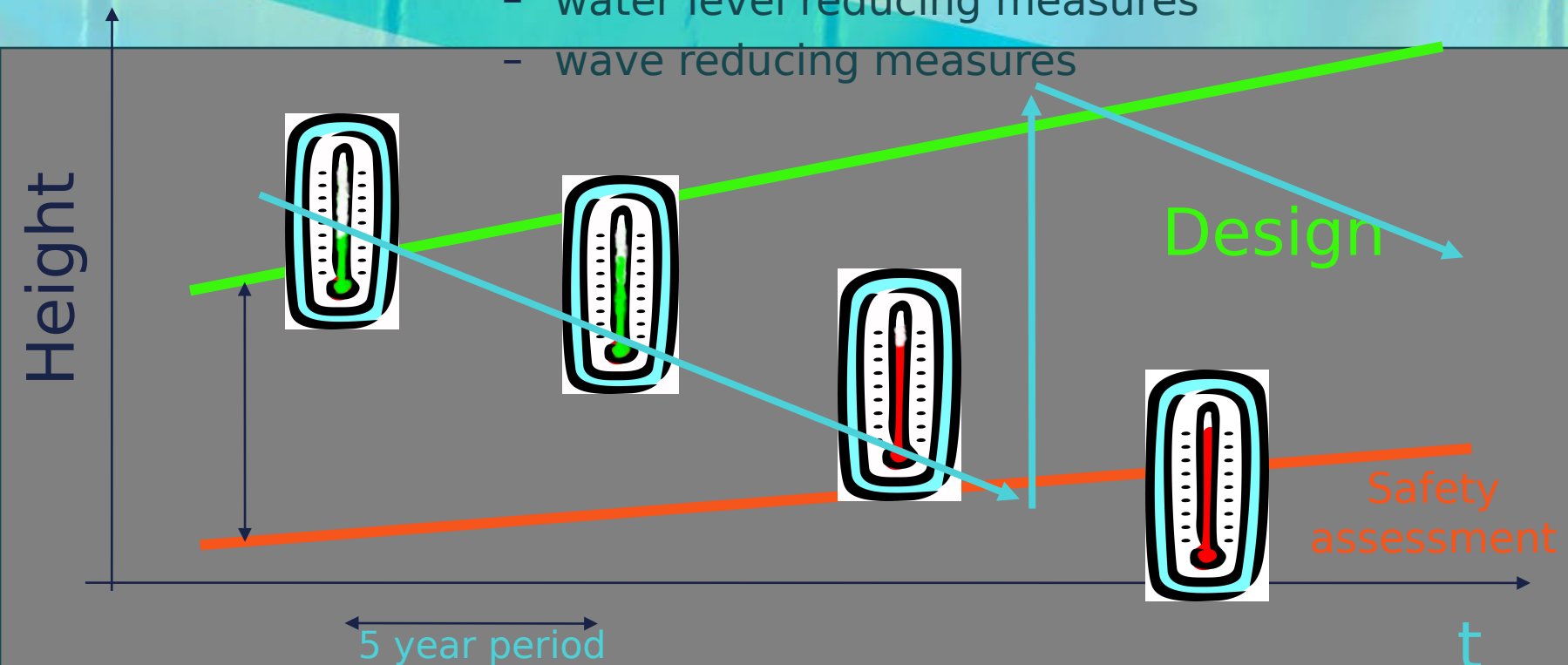
## Hydraulic Boundary Conditions

8  
11 juli  
2006

- renewed each 5 years
- based on actual data
  - Extended series discharges, storm surge data
  - Actual geometrical data, vegetation data, etc.
- using newest, broad accepted insights in modelling the physical processes
- developed by Rijkswaterstaat (in cooperation with the water boards)

# Assessment results

- positive result: OK!
- negative result: measures are necessary
  - dike strengthening
  - water level reducing measures
  - wave reducing measures



# Determining design criteria using computer models

## **Dike strengthening in the Netherlands**

11 juli 2006

- Dike should last for 50-100 years
- Solid design instead of minimal design
- No legislation available
- Design hydraulic conditions are the responsibility of the water boards

# Design conditions $\neq$ Hydraulic Boundary Conditions (1)

Determining design criteria using computer models

11 juli 1  
2006

- climate change
  - river discharges 18000 m<sup>3</sup>/s (now 16000 m<sup>3</sup>/s)
  - increased sea-level rise 35-85 cm/century
  - wind +10% (space reservation)
- new insights in physical processes
  - hydraulic and probabilistic modelling
  - extended series for statistical extrapolation

# Design conditions $\neq$ Hydraulic Boundary Conditions (2)

- autonomous changes
  - morphological changes along the coast
  - summerbed lowering in rivers
  - growing vegetation in the flood plains
- man-induced changes
  - Room for the River-project for the Rhine
  - Sand deposits along coastline

# Determining design criteria using computer models

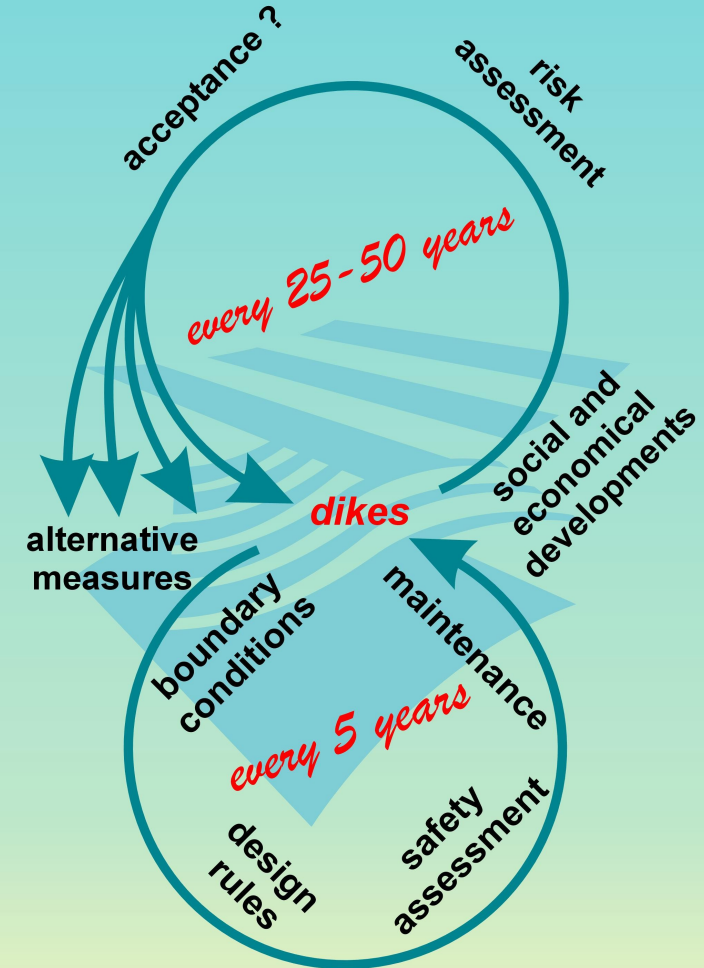
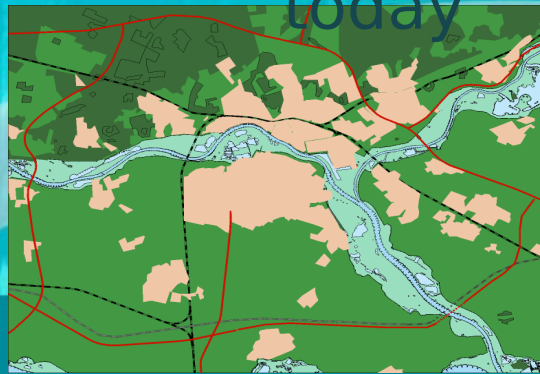
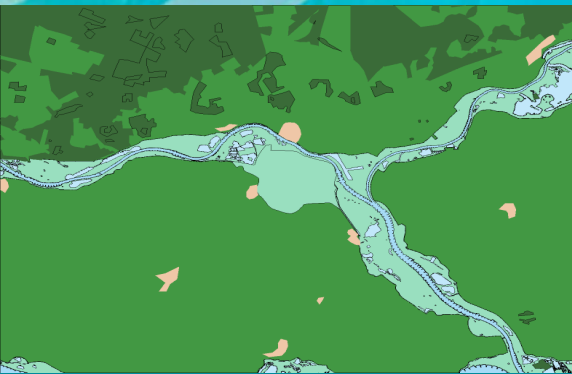
## Design conditions $\neq$ Hydraulic Boundary Conditions (3)

11 juli 3  
2006

- evaluation of the safety policy
  - economical evaluation may change safety standards
  - transition to dike-ring approach

1830

City of Arnhem  
today



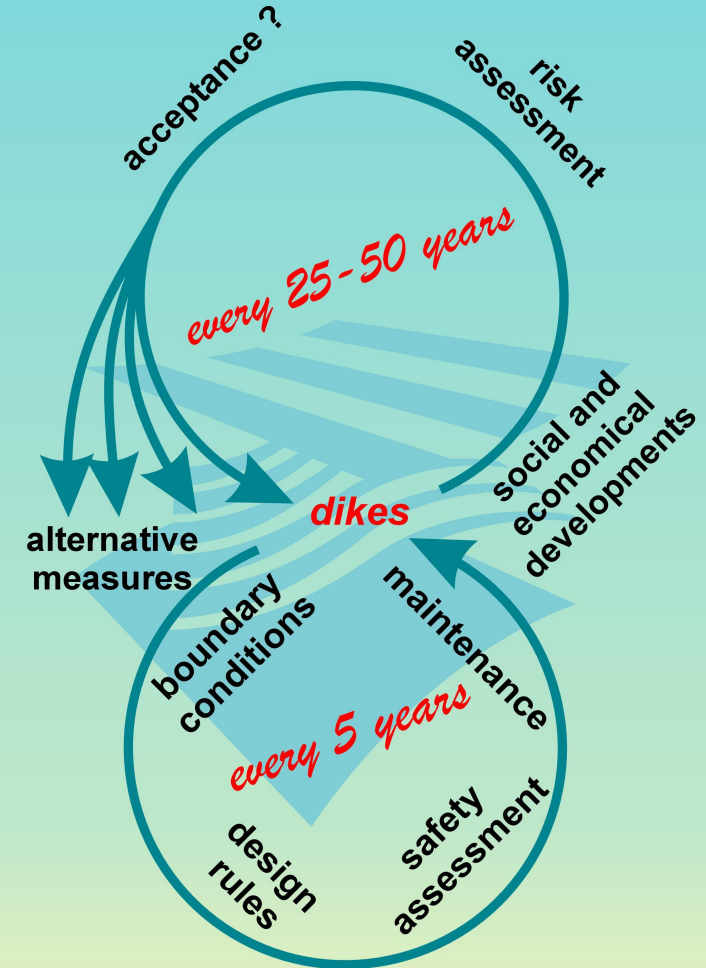
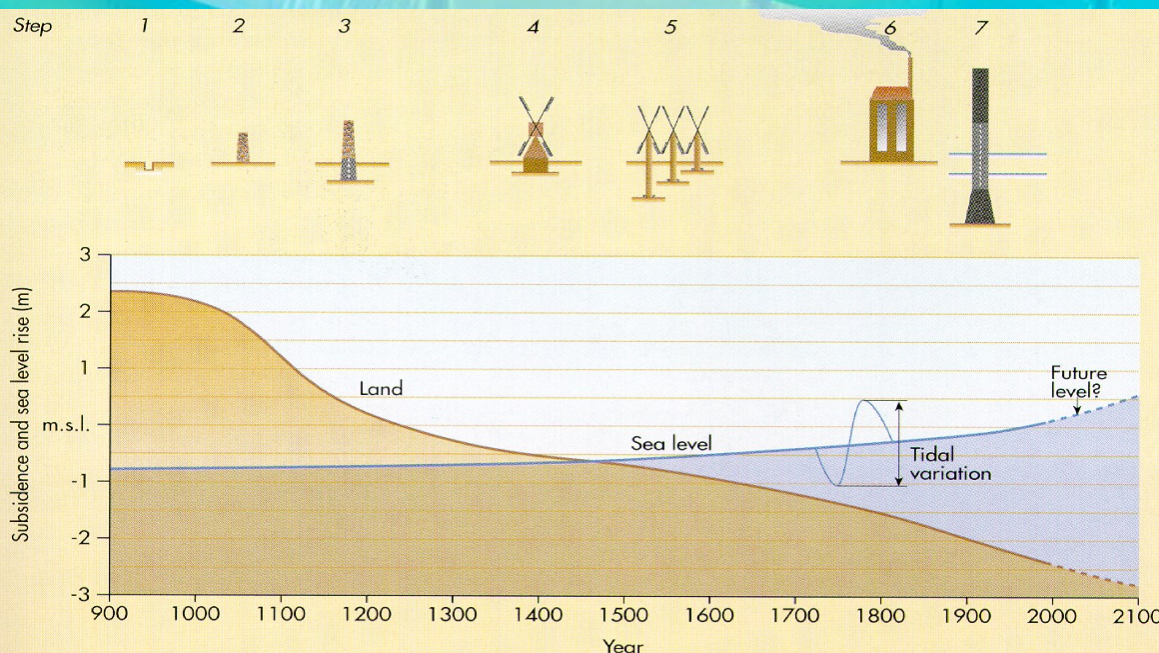
Road and Hydraulic Engineering Division

# Determining design criteria using computer models

## Design conditions $\neq$ Hydraulic Boundary Conditions (3)

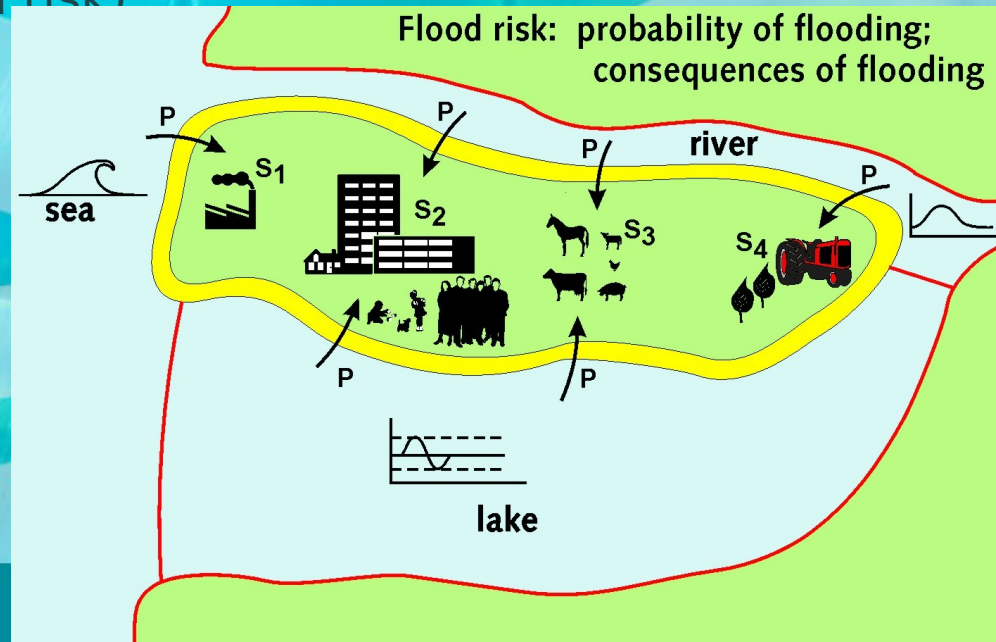
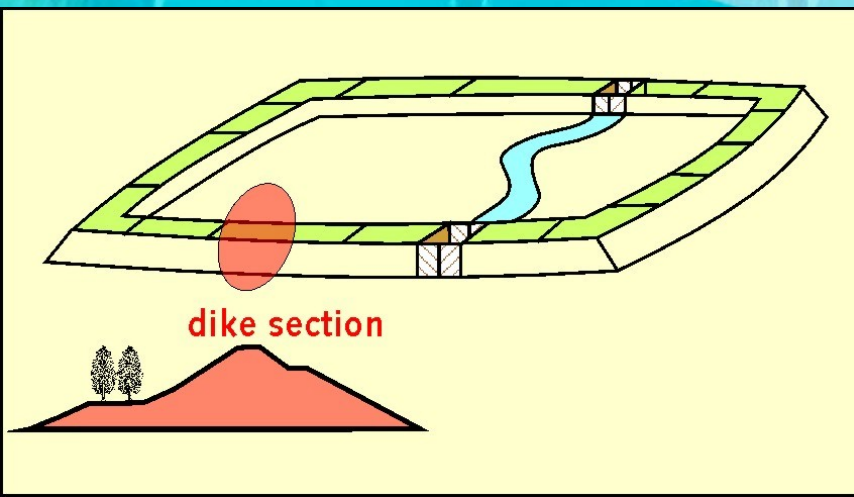
11 juli 4  
2006

- evaluation of the safety policy
  - economical evaluation may change safety standards
  - transition to dike-ring approach



# Design conditions $\neq$ Hydraulic Boundary Conditions (3)

- evaluation of the safety policy
  - economical evaluation may go beyond safety standards
  - transition to dike-ring approach (flood probability or flood risk)



## Conclusions

- 5-yearly safety assessment is performed using actual hydraulic boundary conditions
- In the Netherlands the design conditions are determined by waterboards
- An integrated concept for determining design conditions is being developed